THE EFFECTS OF N-LENGTH AND NUMBER OF PRE-SHIFT TRIALS ON RESISTANCE TO EXTINCTION: A HUMAN ANALOGUE

A Thesis

Presented to

the Faculty of the Department of Psychology

Appalachian State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

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by

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June 1973

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ABSTRACT

Capaldi's stimulus specificity theory, as applied to extinction phenomena, asserts that two variables, N-length and number of preshift trials, are responsible for response decrement during extinction in animals. This study factorially manipulated these variables using human Ss. Data did not support Capaldi's habit generalization approach to experimental extinction.

INTRODUCTION

Many research studies (Jenkins & Stanley, 1950; Lawrence & Festinger, 1962; Capaldi, 1966b; Amsel, cff., 1967) have found that partial reinforcement during acquisition results in greater resistance to extinction (Rn) than continuous reinforcement (CRF). Several theories have been postulated to account for this partial reinforcement extinction effect (PREE). Hull (1956) proposed a hypothetical inhibitory mechanism ($_{S}I_{R}$) which weakens reaction potential and develops as a linear function of successive nonreinforced trials during acquisition in order to explain PREE. Amsel (1958), on the other hand, proposed an expectancy model to account for PREE. With partial reinforcement, specific environmental cues (i.e., goal and alley cues) are conditioned to nonreward (N). Upon continued responding in the presence of these cues, the organism learns to expect reward (R) to follow N. Reward expectancy (r_g-s_g) is conditioned and performance to N elicits the expectancy for reinforcement during extinction. It is assumed that Rn increases directly with the number of nonrewarded trials in acquisition (Lawrence & Festinger, 1962; Amsel, 1958; Spence, 1960).

Unlike other theorists, Capaldi (c.f., 1967) proposed a stimulus specificity notion in which extinction was conceived of as a generalization decrement phenomenon. This hypothesis suggests that each goal event supplies the organism with a specific internal stimulus. Following partial reinforcement in acquisition, however, discrimination is more difficult. Stimuli associated with nonreward (S^N) in acquisition are present during successive N trials of extinction. Thus, the response

decrement found in extinction is partly attributable to the differences in stimuli from preshift to postshift training.

Capaldi's stimulus specificity hypothesis suggests that Rn is regulated by the number of Ns occurring in succession (N-length) in a partial reinforcement schedule during preshift training. In contrast to Lawrence and Festinger's (1962) study in which it was found that groups with the greater number of nonrewarded acquisition trials extinguished least rapidly, Capaldi and Stanley's (1956) research indicated that the number of Ns, per se, is irrelevant. They suggested that the two relevant variables are the number of Ns in sequence, or N-length, and the total number of preshift trials. Capaldi and Senko (1962) found that the number of Ns is important only in that it limits N-length or the number of N-lengths used in a reinforcement schedule. Capaldi (c.f., 1967) further postulated that during partial reinforcement, habit strength ($\overline{H}$) accrues to S^N. Each time R follows N, $\overline{H}$ to S^N increases. The stimuli present at the termination of any trial continue to function until the next R trial. During postshift training, successively longer N-lengths become progressively less similar to the stimuli to which habit was accrued in preshift training.

Recent research (Capaldi & Senko, 1962; Capaldi, c.f. 1967) has indicated that the strength of $\overline{H}$ accruing to N varies as a function of the number of times N is followed by R during acquisition. In a single alternation (SA) reinforcement schedule during preshift (N-R-N-R), N-length is one and $\overline{H}$ quickly accrues because each N is followed by R. It is assumed that during SA, habit is accumulated at S^N and generalizes to S^R, while inhibition is accumulated at S^R and generalizes to S^N. Furthermore, only a minimal number of SA reinforcement trials in the

preshift phase is necessary to increase Rn. When random alternation (RA) acquisition training is employed, $\overline{H}$ does not accumulate as quickly because S^N is not conditioned to R as often in the preshift phase. The stimulus S^N is conditioned to R more often in SA than in RA. Therefore, with a fixed number of acquisition trials, Ss receiving SA in acquisition manifest greater Rn than RA or CRF Ss. Research by Capaldi and Hart (1962) has supported this notion.

Later data (Capaldi, c.f., 1967), however, indicate the reverse is true if a large number of preshift trials are used, due to the greater N-length in RA. When a large number of preshift trials are given, it is assumed that N-length becomes the relevant variable, rather than $\overline{H}$. In an RA schedule, over many trials there are several sequences of N-N-R and N-N-N-R, building up a greater N-length than in SA. The greater N-length makes the preshift phase more similar to the postshift phase. With SA, the N-length is always one regardless of the number of trials. With S^N-R_1 transitions constant, Rn is directly related to N-length (Capaldi, c.f., 1967). When N and R are randomly assigned to a reinforcement schedule, N-length tends to increase as percentage of R decreases (Capaldi, 1966b). Rn increases as N-length increases when the percentage is equated (Gonzalez & Bitterman, 1964). SA schedules result in greater Rn than do RA schedules following limited preshift trials (Capaldi & Hart, 1962) and lesser Rn following extended training (Capaldi, c.f., 1967; Gonzalez & Bitterman, 1964). The major evidence contradictory to at least part of the stimulus specificity notion of Capaldi was reported by Fox (1972). Assuming that experience with the test stimulus is necessary for Rn, Fox found that the relevant variable determing whether N-length acquires $\overline{H}$ is trials, as assured by Spence (1956),

rather than reinforced trials, as hypothesized by Hull (1943) and incorporated by Capaldi.

A major question raised by the stimulus specificity notion is whether $\overline{H}$, per se, or some cognitive process best accounts for Rn. Amsel's (1958) incentive based theory would suggest that a triple alternation (TA) schedule will result in greater Rn than a SA schedule regardless of how many preshift trials are used. According to Amsel's hypothesis, the organism will not be conditioned to expect reward as often following TA. However, if Capaldi is correct in assuming the presence of $\overline{H}$, this outcome is doubtful. Capaldi's (1964) research, however, indicates that SA does result in more Rn than TA following brief acquisition training, as a result of the number of N-R connections; and that TA provides more Rn than SA if a large number of trials is used, due to the greater N-length.

Capaldi's sequential theory of learning has proved to be rather predictive in explaining extinction phenomena. Previous N-length research (Capaldi, c.f., 1967), however, has been solely concerned with rats. It is the primary purpose of the present research to assess the effects of N-length and number of preshift trials on humans and to determine which of the previously cited propositions best explains human data.

METHOD

Subjects: Ss consisted of fifty female and forty male volunteer students enrolled in the Educational Psychology Series (301, 302, 303) at Appalachian State University. All Ss were considered to be low test anxious as evidenced by scores below nine on Sarason's Test Anxiety

Scale (TAS). Ss received varying amounts of extra credit depending on the inclination of individual professors and not related to experimental performance.

Apparatus: Lafayette's reaction time apparatus was used. This apparatus consisted of a 30.48 cm. by 33.02 cm. horizontal wooden base. A vertical board of the same dimensions was attached perpendicular to the base, dividing it into two equal parts. Four 110 volt lamps covered by colored crystals 1 cm. in diameter were mounted on a metal box on the side of the apparatus facing S. A dial and switch capable of turning on any light were mounted on the side facing E. Only two lights, the red and the white, were used in the present research. The apparatus was situated on a table between S and E, both of whom were seated. The vertical board obstructed both S and E from seeing the opposite side of the apparatus. The reaction time capability was not utilized. Rather, this devise was used solely to provide a decision making opportunity; that is, the prediction of which of the two lights would be illuminated on each trial. The testing room was a small, enclosed office which minimized both auditory and visual distractions. The room was empty except for the desk on which the apparatus was situated and two chairs.

Procedure: The experimental design consisted of a preshift and a post-shift phase for each of nine groups which can best be conceptualized as a 3 x 3 factorial design (reinforcement schedule x number of preshift trials). SA, RA, and TA comprised the three preshift reinforcement schedules. Each S had to predict which of the two lights would be scored as correct on each trial. Reinforcement was merely feedback; that is, the illumination of the correct light after a prediction of which light would be presented. This feedback, then was placed on one

of the three reinforcement schedules for each of the three major groups. Table I describes the reinforcement schedule used. In order to maintain the credibility of the experiment, the sequence of lights labelled correct was arbitrarily pre-arranged by E. Table II presents the correct sequence.

Three groups of Ss received forty acquisition trials and three received six trials. In order to control for total time in the experiment, the remaining three groups received six trials following a ten minute delay (time difference between forty and six trials). The factorial combination of the three reinforcement schedules and three levels of preshift training trials yielded the following nine groups of ten Ss per group:

SA- 40	SA- 6	SA- D- 6
RA- 40	RA- 6	RA- D- 6
TA- 40	TA- 6	TA- D- 6

Each S was randomly assigned to one of the nine groups as he entered the testing room and each was tested individually. The following instructions were read to each S:

> "We are only going to be using the first two lights: the red one and the white one. All you have to do is tell me which light will come on next. The lights will come on in a prearranged sequence. Part of the time the correct light will come on, part of the time neither light will come on. Whether or not the correct light comes on has nothing to do with whether your choices are correct or incorrect. Part of the time the correct light will come on and part of the time neither of the lights will come on no matter what you say. A friend of mine did this experiment with just a few students and found a slight correlation between the ability to figure out the sequence and some personality variables. I am trying to duplicate his study. All right, all you do is tell me which light will come on next. Start now."

During preshift training, the number of trials predicted correctly was recorded by E. After either forty or six trials, depending on the group to which S was assigned, the following statement was read by E:

Table I

Reinforcement Schedules

Single Alternation		Random Alternation		Triple Alternation	
Trial	Light	Trial	Light	Trial	Light
1	no	1	red	1	no
2	red	2	no	2	no
3	no	3	white	3	no
4	white	4	no	4	white
5	no	5	no	5	red
6	red	6	red	6	red
7	no	7	no	7	no
8	red	8	red	8	no
9	no	9	no	9	no
10	white	10	no	10	white
11	no	11	white	11	white
12	white	12	no	12	white
13	no	13	red	13	no
14	red	14	no	14	no
15	no	15	red	15	no
16	red	16	red	16	red
17	no	17	red	17	red
18	red	18	no	18	red
19	no	19	no	19	no
20	white	20	white	20	no
21	no	21	no	21	no
22	white	22	white	22	white
23	no	23	white	23	white
24	white	24	no	24	white
25	no	25	no	25	no
26	red	26	no	26	no
27	no	27	red	27	no
28	red	28	red	28	red
29	no	29	no	29	red
30	red	30	red	30	red
31	no	31	red	31	no
32	red	32	no	32	no
33	no	33	no	33	no
34	white	34	white	34	white
35	no	35	no	35	white
36	white	36	no	36	white
37	no	37	no	37	no
38	white	38	white	38	no
39	no	39	white	39	no
40	white	40	white	40	white

Table II

Sequence

1.	red	21.	white
2.	red	22.	white
3.	white	23.	white
4.	white	24.	white
5.	red	25.	red
6.	red	26.	red
7.	red	27.	red
8.	red	28.	red
9.	white	29.	red
10.	white	30.	red
11.	white	31.	red
12.	white	32.	red
13.	red	33.	white
14.	red	34.	white
15.	red	35.	white
16.	red	36.	white
17.	red	37.	white
18.	red	38.	white
19.	white	39.	white
20.	white	40.	white

> "When you have decided you have done this enough, just tell me and you can quit. It makes no difference to me how many times you do it."

The onset of the extinction phase immediately followed completion of preshift training (no reinforcement was presented). Ss were allowed to continue performing until they asked to stop. Upon completion, Ss were told they could leave.

RESULTS

The results of the study did not support the stimulus specificity notion. Table III shows the mean number of trials each group persisted on the task. Analysis of variance was performed over the two factors (reinforcement schedule and number of preshift trials). Capaldi's (c.f., 1967) assumption that an N-length of one with a small number of acquisition trials results in increased Rn relative to longer N-lengths was not supported by the present research. The main effect of reinforcement schedule (Factor A) was not statistically significant ($F(89,2) = .538$; $p > .10$). The hypothesis that a large number of preshift trials results in greater Rn than fewer preshift trials (Capaldi, c.f., 1967) was not supported. The main effect of number of preshift trials presented (Factor B) was not statistically significant ($F(89,2) = 1.767$; $p > .10$). Finally, the interaction between the two factors was nonsignificant ($F(89,4) = .801$; $p > .10$).

DISCUSSION

An important variable which may have effected the results is R-length. Capaldi's research indicates that in order to increase response decrement with short N-lengths, R-length should be held to one. When R-length is two, N-length of two results in less response decrement than R-length of one (Capaldi, c.f., 1967). The fact that RA

Table III

Group Means

SA-40 = 42.300	SA-6 = 99.900	SA-D-6 = 71.700
RA-40 = 51.400	RA-6 = 53.800	RA-D-6 = 63.300
TA-40 = 50.400	TA-6 = 79.100	TA-D-6 = 79.100

groups had an R-length of two and TA groups an R-length of three, could explain the lack of a significant reinforcement schedule effect.

The use of knowledge of results (KOR) as the reinforcement, could account, at least in part, for the failure to achieve significant results. Although research indicates that KOR is reinforcing (Christie & Smothergill, 1970; Lack, 1970; Mandell, 1970), it was perhaps used inappropriately in this instance. Capaldi (c.f., 1967) employed primary reinforcement in the form of food. KOR, while an accepted form of reward, is nevertheless a secondary reinforcement rather than a primary reinforcement. Thus, Capaldi's (c.f., 1967) experimental conditions were not duplicated in the present research.

Neither Capaldi's stimulus specificity theory nor Amsel's expectancy model was supported by the present research since no PREE was found. It is suggested that further research is needed to explain Rn in human Ss.

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APPENDIX A

Simple Analysis of Variance for Reinforcement

Schedule x Number of Preshift Trials

Source	df	SS	MS	F
Factor A (reinforcement schedule)	2	3438.47	1719.23	.538
Factor B (number of pre-shift trials)	2	11291.67	5645.83	1.767
A x B Interaction	4	10232.87	2558.22	.801
Error	81	258861.40	3195.82	
Total	89	283824.40		